

What is claimed is:

1. A method for producing a polymer or oligomer with controlled molecular weight and desired end group functionality comprising
 - a) forming a microemulsion comprising monomer, water, and an effective amount of an effective surfactant,
 - b) adding to the microemulsion an amount of a water-soluble photo-initiator system wherein the initiator system produces one type of monomer-soluble radical active centers and wherein the radical active centers contain desired end group functionalities for a polymer or oligomer, and
 - c) illuminating the microemulsion to photoinitiate polymerization of the monomer wherein the illuminating is according to a temporal and spatial illumination scheme, and
wherein the amount of the initiator system and the temporal illumination scheme are chosen to produce a desired molecular weight of the polymer or oligomer.
2. The method of claim 1 wherein the microemulsion further comprises an effective amount of an effective co-surfactant.
3. The method of claim 1 wherein the monomer comprises an acrylate, a methacrylate, a styrene, an α -methyl styrene, a 1,3-diene, a halogenated olefin, a vinyl ester, an acrylonitrile, a methacrylonitrile, an acrylamide, a methacrylamide, or mixtures thereof.
4. The method of claim 1 wherein the monomer comprises methyl acrylate, ethyl acrylate, butyl acrylate, hydroxyethyl acrylate, alkyl acrylate, acrylonitrile, styrene, or mixtures thereof.
5. The method of claim 1 wherein the monomer comprises methyl(methacrylate), hydroxyethyl methacrylate, ethene, hexanediol dimethacrylate, vinyl chloride,

methyl acrylate, alkyl methacrylate or mixtures thereof.

6. The method of claim 1 wherein the monomer comprises an acrylate, a methacrylate, methyl acrylate, ethyl acrylate, butyl acrylate, hydroxyethyl acrylate, alkyl acrylate, methyl(methacrylate), hydroxyethyl methacrylate, hexanediol dimethacrylate, or mixtures thereof.
7. The method of claim 1 wherein the monomer comprises a styrene, an α -methyl styrene or mixtures thereof.
8. The method of claim 1 wherein the monomer comprises a 1,3-diene, ethene, or mixtures thereof.
9. The method of claim 1 wherein the monomer comprises a halogenated olefin.
10. The method of claim 1 wherein the monomer comprises a vinyl chloride.
11. The method of claim 1 wherein the monomer comprises a vinyl ester.
12. The method of claim 1 wherein the monomer comprises an acrylonitrile, a methacrylonitrile, or mixtures thereof.
13. The method of claim 1 wherein the monomer comprises an acrylamide, a methacrylamide, or mixtures thereof.
14. The method of claim 1 wherein the monomer is butyl acrylate.
15. The method of claim 1 wherein the monomer is chosen for its preferred mode of termination.
16. The method of claim 1 wherein the monomer determines whether the polymer has one or two end groups of the desired functionality.
17. The method of claim 1 wherein the monomer and initiator system are chosen to

select the type and number of end group functionalities.

18. The method of claim 2 wherein the surfactant and co-surfactant are chosen based on the calculated hydrophile-lipophile balance (HLB) number wherein the HLB number is that at which the monomer will be emulsified.
19. The method of claim 1 wherein the surfactant comprises sodium dodecyl sulfate, Triton® (octyl phenoxy poly(ethoxy) ethanol), Tergitol® (alcohols and ethoxylates), Neodol® (propylene oxide/ethylene oxide copolymer), Brij® 97 (polyoxyethylene-10-oleyl ether), Mazol® 80 MG Kosher (ethoxylated monodiglycerides), or mixtures thereof.
20. The method of claim 2 wherein the co-surfactant comprises propanol, butanol, pentanol, hexanol, heptanol, dodecanol, hexadecanol, ethylene glycol, glycerin, propylene glycol, or mixtures thereof.
21. The method of claim 1 wherein the surfactant is sodium dodecyl sulfate.
22. The method of claim 2 wherein the co-surfactant is 1-pentanol.
23. The method of claim 1 wherein the end group functionality is a hydroxyl, isocyanate, cyanide, nitro, nitrile, or amine.
24. The method of claim 1 wherein the initiator system is about 0.1 to about 10 wt% of the monomer.
25. The method of claim 1 wherein the initiator system is about 4 to about 6 wt% of the monomer.
26. The method of claim 1 wherein the initiator system is a one-component initiator system.
27. The method of claim 1 wherein the initiator system is a two-component initiator

system.

28. The method of claim 1 wherein the initiator system is a hydrogen abstraction initiator.
29. The method of claim 1 wherein the initiator system comprises hydroxyl alkyl ketone (HAP), 4-(2-hydroxyethoxy)phenyl-(2-hydroxy-2-propyl)ketone (HPPK), methyl thio phenyl morpholino ketone (TPMK), or sulfonic ester of α -hydroxy methyl benzoin derivative.
30. The method of claim 1 wherein the initiator system comprises iodonium salt, triaryl sulfonium salt, amino ketone, acetophenone, benzophenone, thioxanthone, or benzyl.
31. The method of claim 27 wherein the two-component system comprises one light-absorbing component and a second component which reacts with the excited state of the light-absorbing component.
32. The method of claim 31 wherein the light absorbing component absorbs light in a desired initiating region of the spectrum.
33. The method of claim 31 wherein the second component is an electron donor and the light absorbing component has a reduced potential which makes electron transfer thermodynamically feasible.
34. The method of claim 31 wherein the second component is an electron acceptor and the light absorbing component has an oxidation potential which makes electron transfer thermodynamically feasible.
35. The method of claim 31 wherein the light absorbing component comprises methylene blue, rose bengal, eosin Y, fluorescein, rhodamine, sulforhodamine, or cyanine.

36. The method of claim 33 wherein the electron donor second component is trimethylamine, 1,2',3"-trichlorotripropylamine, triethylamine, N,N-dimethylpentylamine, N,N-dimethyl-m-nitroaniline, dimethylethanolamine (DMEA), N,N-dimethylcyclohexylamine, 3,3',3"-nitrilotripropionic acid, N-ethyl-N-propyl-1-acridinamine, N-phenylglycine, N,N-dimethylacetamide, N,N-dimethylurea, methyldiethanolamine (MDEA), N,N-dimethylbenz[a]antracen-6-amine, 3,9-dimethyl-3,6,9-triazadodecanedioic acid, N-ethyl-N-propylaniline, or N,N-diethyl-2-furanamine.
37. The method of claim 34 wherein the electron acceptor second component is diazonium salt, diphenyl iodonium salt, triphenyl sulfonium salt, dialkyl-4-hydroxyphenylsulfonium salt, dialkyl phenacyl sulfonium salt, pyrylium salt, thiopyrylium salt, pyridinium salt, or quinolinium salt.
38. The method of claim 1 wherein the initiator system comprises methylene blue and N-methyldiethanolamine.
39. The method of claim 28 wherein the hydrogen abstraction initiator system comprises diphenyl iodonium chloride.
40. The method of claim 1 wherein the molecular weight of the polymer or oligomer is determined by the amount of initiator.
41. The method of claim 1 wherein the molecular weight of the polymer or oligomer is determined by the temporal illumination scheme.
42. The method of claim 1 wherein the molecular weight of the polymer or oligomer is determined by the amount of initiator and the temporal illumination scheme.
43. The method of claim 1 wherein the polymer or oligomer has a polydispersity index of about 1 to about 2.

44. The method of claim 1 wherein the illuminating is with UV light.
45. The method of claim 1 wherein the illuminating is with visible light.
46. The method of claim 1 wherein the method is performed at about room temperature.
47. The method of claim 1 further comprising reacting end group functionalities of the polymers or oligomers to produce a copolymer.
48. The method of claim 47 further comprising separating the end functionalized polymers or oligomers from the microemulsion prior to reacting the end groups.
49. The method of claim 40 further comprising purifying the separated polymers or oligomers.
50. The method of claim 47 wherein the reacting of the end groups is a copolymerization reaction.
51. The method of claim 1 wherein the polymer terminates by combination and wherein the end functionalities are the same.
52. The method of claim 47 wherein the copolymer is a block copolymer.
53. The method of claim 1 wherein the polymer terminates by disproportionation.
54. The method of claim 47 wherein the copolymer is a graft copolymer.
55. The method of claim 1 wherein the monomer is selected by its preferred mode of termination and wherein the selection of monomer determines whether each chain contains one or two end groups of the specified functionality.
56. The method of claim 53 wherein the method is carried out at a temperature chosen to determine the desired degree of disproportionation.

57. The polymer produced by the method of claim 1.
58. The copolymer produced by the method of claim 47.
59. A method for producing a copolymer comprising
 - a) forming a microemulsion comprising monomer, water, and an effective amount of an effective surfactant,
 - b) adding to the microemulsion an amount of a water-soluble photo-initiator system wherein the initiator system produces one type of monomer-soluble radical active centers and wherein the radical active centers contain desired end group functionalities for a polymer or oligomer, and
 - c) illuminating the microemulsion to photoinitiate polymerization of the monomer wherein the illuminating is according to a temporal and spatial illumination scheme, and
 - wherein the amount of the initiator system and the temporal illumination scheme are chosen to produce a desired molecular weight of the polymer or oligomer, and
 - d) reacting the end group functionalities of the polymers or oligomers to produce copolymers.
60. The method of claim 59 wherein the microemulsion further comprises an effective amount of an effective co-surfactant.
61. The method of claim 59 wherein the copolymer is a block copolymer.
62. The method of claim 59 wherein the copolymer is a graft copolymer.
63. The method of claim 61 wherein the end functionalized polymers or oligomers have the same end groups and wherein the end functionalized polymers are combined.
64. The method of claim 62 wherein the end functionalized polymers or oligomers are terminated via disproportionation.

65. The method of claim 59 further comprising separating the end-functionalized polymers or oligomers from the microemulsion prior to reacting the end groups.
66. The method of claim 65 further comprising purifying the separated polymers or oligomers.
67. The method of claim 65 wherein the reacting of the end groups is a copolymerization reaction.
68. A polymer produced by a method comprising
 - a) forming a microemulsion comprising monomer, water, and an effective amount of an effective surfactant,
 - b) adding to the microemulsion an amount of a water-soluble photo-initiator system wherein the initiator system produces one type of monomer-soluble radical active centers and wherein the radical active centers contain desired end group functionalities for a polymer or oligomer, and
 - c) illuminating the microemulsion to photoinitiate polymerization of the monomer wherein the illuminating is according to a temporal and spatial illumination scheme, and
wherein the amount of the initiator system and the temporal illumination scheme are chosen to produce a desired molecular weight of the polymer or oligomer.
69. A copolymer produced by a method comprising
 - a) forming a microemulsion comprising monomer, water, and an effective amount of an effective surfactant,
 - b) adding to the microemulsion an amount of a water-soluble photo-initiator system wherein the initiator system produces one type of monomer-soluble radical active centers and wherein the radical active centers contain desired end group functionalities for a polymer or oligomer, and
 - c) illuminating the microemulsion to photoinitiate polymerization of the monomer

wherein the illuminating is according to a temporal and spatial illumination scheme, and

wherein the amount of the initiator system and the temporal illumination scheme are chosen to produce a desired molecular weight of the polymer or oligomer, and

d) reacting the end group functionalities of the polymers or oligomers to produce copolymers.